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May 7, 2004

BY HAND AND BY E-MAIL

Mary L. Cottrell, Secretary
Department of Telecommunications and Energy
One South Station, 2nd Floor
Boston, MA 02110

      Re: NStar Companies, D.T.E. 03-121

Dear Secretary Cottrell:

      Enclosed for filing in the above-referenced proceeding is a correction to Response of Joint Supporters to NSTAR Electric First Set Of Information Requests To the Joint Supporters, which was previously filed with the Department on April 6, 2004. The enclosed article – "Saving California with Distributed Generation" by Mark Lively – replaces the pages that were included in the prior filing as Attachment NSTAR-JS-1-4(h). In an inadvertent production error, the wrong pages were attached to the original response. Note that while the original 1-4(h) was part of a bulk document response, Joint Supporters are serving the corrected pages on all parties and Department staff on the service list.

      Please do not hesitate to call if you have any questions. Please acknowledge receipt by stamping the enclosed copy of this letter and returning it to the messenger. Thank you.

      Sincerely,

Bruce S. Barnett

BSB/lnf
Enclosure

Piper Rudnick LLP

cc: William Stevens, Hearing Officer (by hand)
John Cope-Flanagan, Hearing Officer (by hand)
Sean Hanley (by hand)
Claude Francisco (by hand)
Xuan Yu (by hand)
Robert Harrold (by hand)
Jeff Hall (by hand)
Joseph Passaggio (by hand)
Meera Bhalotra (by hand)
David S. Rosenzweig, Esq.
D.T.E. 03-121 Service List (By U.S. mail or e-mail)

Attachment NSTAR-JS-1-4 (h)

"Saving California with Distributed Generation:
A crash program to use small, standby diesel
generation to keep the lights on."
Public Utilities Fortnightly,
2001 June 15

Saving
CALIFORNIA
with

A crash program to use small, standby diesel generators to keep the lights on.

By Mark B. Lively

CALIFORNIA IS SHORT OF POWER. SOME STUDIES predict over 1,000 hours of rotating blackouts this summer for the state's electricity users. Yet these blackouts need not occur.

It is true, of course, that the industry cannot possibly install enough *new generation* to offset the power shortage before the peak air conditioning season hits in July. But what about power plants *already on the ground* that go largely unused? Here I'm talking about some 30 gigawatts (GW, or thousands of megawatts) of distributed generation that is already in place in California, made up for the most part of diesel-powered emergency standby generators.

Diesel fuel combustion, unfortunately, is not anyone's vision of "green" power. It poses an environmental challenge. Even so, the electric industry ought to be able to mobilize a significant fraction of these assets. The engineering isn't all that difficult, but the politics and economics must still be solved, before these plants can become available to offset California's electricity shortage.

- Will California allow these environmentally unfriendly generators to operate to prevent rotating blackouts or to reduce their severity?
- Will California be willing to pay these emergency generators enough to get them to produce electricity during the many hours that these emergency generators are needed this summer?

Distributed Generation

The answers may depend on the way the electric industry comes to grips with customer-owned, distributed generation. First, how utilities meter the output of small-scale customer-owned generation. Second, how will the utilities calculate the billing credit or offset that customers receive for reselling energy back to the grid, rather than drawing on the state's short energy supplies?

As things stand now, standard metering practices and billing credits don't do the trick. They don't give customers the right kind of incentives to mobilize distributed generation. Instead, we need switched meters so that customers can go "off" the util-

ity system when they run on-site generation. And we need billing credits tied to the real-time wholesale commodity price of bulk power, not controlled by various price

Will California allow these environmentally unfriendly generators to operate?

caps adopted as a political solution to mitigate and fix the power price that consumers pay under retail tariffs.

Standby Power Currently Installed

Caterpillar Inc. periodically prepares a list of domestic generating sets installed around the world. The list enables Caterpillar's regional dealers to identify maintenance opportunities. The list is an equal opportunity list, in that the list includes not only Caterpillar brand equipment, but also generating sets manufactured by other companies. The last summary of the data, as obtained by the author from third parties believed to be reliable, is presented in Table 1. Since the summary is based on data that is a few years old, the current number of generating sets is likely to be much greater. The third party provided this summary to the California governor's office as early as November 2000 and to the federal Department of Energy as early as April 1, 2001.

Table 1 shows that at last count, the state of California could claim within its borders as many as 22,405 individual small generating sets, posting a capacity rating of between 50 and 70 kilowatts (kW). The total number of standby gensets rises to 79,882 when we take into account units of a size ranging from 50 kW to 2000 kW (2 MW) and greater.

Obviously, not all of the generating sets identified in Table 1 are available for delivering electricity into the grid. Some may not be operable. Others may be used on remote construction sites. Further, the data in Table 1 may not be accurate, even though the data are nominally based on an actual count of generator sets. However, we would expect that the vast majority of these generators are serving as emergency generators, standing ready to operate when the local distribution grid stops delivering electricity to a customer location. Typically such calls for emergency generation occur when there is a distribution fault or rotating blackouts have been implemented.

Table 2 evaluates the total capacity of the generation sets indicated in Table 1. To calculate total capacity for the units in each of the first six columns, I've taken the midpoint of the range as a nominal capacity value and have assigned that value for all the gensets in the category. For the last

Table 1: Standby Gensets (Installed Units)
Distribution across Western States

Range (kW) State	50-70	71-150	151-300	301-700	701-1200	1201-2000	2001+	Total
California	22,405	23,558	14,373	7,062	5,259	5,257	1,968	79,882
Washington	3,699	3,553	4,060	1,400	916	812	304	14,744
Arizona	2,961	1,421	2,708	1,120	220	650	230	9,310
Oregon	2,143	2,058	1,960	811	530	470	176	8,148
Nevada	1,072	1,029	980	406	266	236	83	4,072
Colorado	2,556	2,700	3,273	967	506	561	201	10,764
Utah	1,337	1,284	978	506	332	294	110	4,841
New Mexico	1,145	1,100	1,047	433	283	251	94	4,353
Montana	547	621	538	222	146	129	48	2,251
Wyoming	321	494	323	122	80	71	27	1,438
Total	38,186	37,818	30,240	13,049	8,538	8,731	3,241	139,803

Table 2: Standby Gensets (Capacity, MW)
Distribution across Western States

Range (kW) Nominal (kW) State	50-70 60	71-150 110	151-300 220	301-700 500	701-1200 950	1201-2000 1600	2001+ 3000	Total
California	1,344	2,591	3,162	3,531	4,996	8,411	5,904	29,940
Washington	222	391	893	700	870	1,299	912	5,287
Arizona	178	156	596	560	209	1,040	690	3,429
Oregon	129	226	431	406	504	752	528	2,975
Nevada	64	113	216	203	253	378	249	1,475
Colorado	153	297	720	484	481	898	603	3,635
Utah	80	141	215	253	315	470	330	1,805
New Mexico	69	121	230	217	269	402	282	1,589
Montana	33	68	118	111	139	206	144	820
Wyoming	19	54	71	61	76	114	81	476
Total	2,291	4,160	6,653	6,525	8,111	13,970	9,723	51,432

column, with generator capacity in excess of 2000 kW, I have used 3000 kW as the average nominal capacity of this group of generator sets. Based on this evaluation method, there are 30 GW of distributed generation installed in California, just in the form of stationary diesel engines alone. This capacity of 30 GW is not only many times the anticipated shortfall this summer in California, but it rivals the size of the entire fleet of central station generators in California, including the state's ability to import for the rest of the West. The 51 GW of diesel capacity in the West is similarly impressive.

Connecting to the Grid

Some customers use their generating sets to shave the peak demands imposed on the utility. The generators would be wired to operate in parallel with the utility. The generator can supply energy to the load or to the utility. The load can receive energy from the Utility or from the generator. The meter measures the net energy delivered from the utility to the customer. Détentes can prevent the meter from running backward, preventing the customer from receiving credit for generation in excess of load.

Though the simple configuration shown in Figure 1 allows the customer to deliver electricity to the utility, the metering scheme skews the economics. We want generators to have a market incentive to produce electricity when California is in an alert, or at least not to be economically disadvantaged by helping the electric network. With net metering, as the term is commonly understood, in Figure 1 the customer has a two-tiered incentive to generate electricity, and the first tier is clearly insufficient. Thus, for low levels of generation, the customer's incentive is equal to the price that the customer is paying for electricity at retail. That is not the competitive market price that is needed to provide an incentive to the customer to generate electricity. The customer does not receive a market incentive to generate until the generation level is in excess of the customer's load level, when the customer is not just offsetting his own demand, but is actually contributing new supply to the grid.
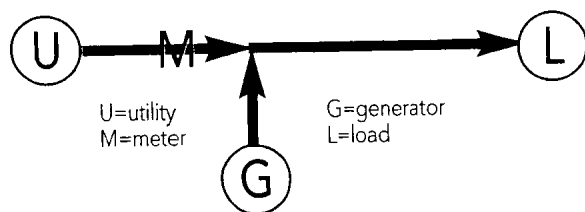
Figure 1: Peak Shaving Interconnection Diagram

U=utility
M=meter
G=generator
L=load

The absence of a market incentive to generate electricity is demonstrated in Table 3, which shows the economics for an industrial or large commercial customer of running a 100 kW emergency generator set at a variety of emergency prices under net metering. When the customer has an emergency, the generator provides 80 kW to the customer's load. Normally the customer buys this electricity from the utility at an assumed unit price of $100/MWh (10 cents per kWh), including both the energy commodity and the various wires services. In our case, at a consumption level of 80 kilowatts, the cost works out to $8 an hour. When the utility has an emergency, net metering requires the customer to serve its own load first. The customer then is able to sell only its excess, 20 kW, to the utility. At wholesale bulk power price of $250/MWh,

a frequently used cap in California, the customer would receive $5/hour for this 20 kW of electricity.

Table 3 assumes that the customer has fuel costs of $150/MWh or $15/hour at 100 kW. The cost of this fuel must be considered as an offset to the revenue earned by the customer selling electricity to the utility. Thus, the customer, operating its generator at a fuel cost of $15/hour and earning revenue of only $5/hour, nominally loses $10/hour in providing assistance to the utility. In actuality, the accounting for the transaction must include the normal cost to the customer of the electricity it would otherwise have purchased from the utility, $8/hour. This reduces the customer loss to $2/hour. Under the net metering concept, the customer has little incentive to run its generator except when a rotating blackout hits its facility, or the price for power gets significantly greater than $250/MWh. Under the assumptions in Table 3, the price

for emergency power must reach $350/MWh for the customer to even consider operating its generating set to help the network keep the lights on.

Table 3 also presents a range of emergency prices for the electricity provided by the customer to the utility. The three middle prices of $250/MWh, $500/MWh, and $750/MWh have been used in California as caps on the price paid to power marketers for electricity paid to the grid. Table 3 ends with prices of $1,000/MWh and $5,000/MWh. These prices are much above the levels that have been permitted in the California market, until recently, when prices reportedly hit $1,900/MWh. However, these sample prices have been seen in the Midwest during crises that occurred during the summers of 1998 and 1999. During those crises, prices were reported in excess of $7,000/MWh. The prices got that high even though the Midwest utilities did not implement the rotating blackouts that have occurred in the constrained California market.

Rewiring the Customer Site

The simple configuration shown in Figure 1 can be modified slightly to provide the customer with a market incentive to operate the generator set. That slight reconfiguration involves adding a second meter to measure the output of the generator. The output of the generator is priced at the market price of electricity, providing a market incentive to operate the generator when California is in an alert. The readings from the two meters would be combined to determine the Load served by the Utility at the standard rate. Alternative arrangements include separate meters on the load and the generator or separate meters on the utility feed and the load.

As is demonstrated in Table 3, most of the time the market price applicable to the generator would be too low for the customer to consider running the generator under net metering arrangements. The incentive can be improved by separate metering of the generation and the load. Table 4 presents the results of such a "buy all, sell all" arrangement.

Table 4 includes the same prices for emergency electricity as were used in Table 3. However, the utility pays for the entire 100 kW output of the generating set, instead of just the last 20 kW. The customer now has an economic incentive to produce electricity when the emergency price exceeds the customer's cost of generating electricity, or $150/MWh in the example. In contrast, under the conditions presented in Table 3, the customer did not have an incentive to operate its generator to help the grid until the price reached $350/MWh, substantially in excess of the customer's cost of production.

Of course, this capacity of 30 GW of diesel generator sets in California may not be wired to operate in parallel with the power system. Most of the generator sets are likely to be emer-

Table 4: Buy-All, Sell-All*
Customer w/ 100-kW unit turns profit at $150/MWh when selling all gross output back to utility.

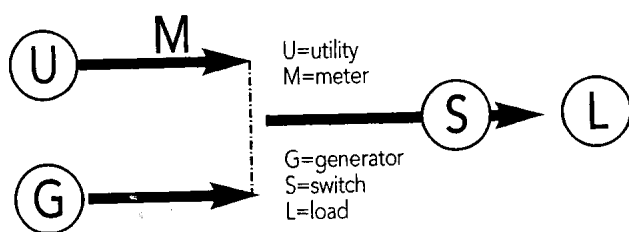| Emergency Price $/MWh	Sales Revenue $/Hour	Net of Fuel Cost $/Hour
100	10	-5
150	15	0
200	20	5
250	25	10
500	50	35
750	75	60
1,000	100	85
5,000	500	485

*Assumptions:

1. Customer pays retail electricity price $100/MWh (10 cents per kWh), on load of 80 kW, and takes utility service at retail price for all 80 kW of load. This assumption does not impact the numbers in Table 4.
2. Customer operates generator at 100 kW, at fuel cost of $150/MWh (15 cents per kWh), and sells 100 kW back to grid at "emergency price," rather than use output to first offset load supplied by utility.
3. "Sales Revenue" indicates revenue received for selling 100 kW back to utility at indicated price.
4. "Net of Fuel Cost" represents revenue minus fuel cost.

ncy generators. Emergency genera-
..ors often have switches to isolate the
associated load from the grid before
connecting the load to the emergency
generators. Indeed, some advocates of
distributed generation claim that the
inability of generators to operate in
parallel to the utility will eliminate a
substantial portion of the generator
sets in the Caterpillar database.

The switch in Figure 2 connects
the load to either the utility or to the
genset. The utility meter is located
between the switch and the utility, so
that only energy moving from the
utility to the load is included in the
meter reading. The switching scheme
also prevents the generator from pro-
viding electricity to the utility or even operating in parallel to
the utility. The switching scheme thus prevents the customer
from using the generator as a peak shaving device to lower
the demand charge billed to the customer on a monthly
basis. The switching scheme also prevents the customer from
delivering to the utility any energy that could be generated in
excess of the customer's load requirement.

Table 5: Adding In Transaction Costs
Profits come only if customers avoid huge investment
needed for full SCADA system.

| | | | Hours Needed to Break Even | |
Emergency Price $/MWh	Sales Revenue $/Hour	Net of Fuel Cost $/Hour	Transaction Cost $500	Transaction Cost $150,000
100	10	-5	N/A	N/A
150	15	0	N/A	N/A
200	20	5	100	30,000
250	25	10	50	15,000
500	50	35	15	4,286
750	75	60	9	2,500
1,000	100	85	6	1,765
5,000	500	485	2	310

Figure 2: Switched Interconnection Scheme

U=utility
M=meter
G=generator
S=switch
L=load

Transaction Costs

The number of generating sets listed in Table 1 looks impres-
sive at first glance, at least until one considers the significance
of the small size of the individual units. Most people would
question the usefulness of generators under the size of 1 MW
during an age when new generators are in the range of 100
MW to 1,000 MW. In a similar vein, the California
Independent System Operator (ISO) requires generation to
be aggregated into blocks no smaller than 25 MW. Indeed,
some distributed generation advocates have looked at the
data in Table 1 and concluded that over half of the generators
would have a transaction cost that is too high for the gener-
ating set to be considered useful in saving California, this
summer or any time in the future. The small size of these

generating sets requires an approach that
reduces the transaction cost of equipping
these generators to provide power to the
electric grid on an emergency basis.

The small sizes of these generating sets
should be viewed in relation to the small
sizes of utility loads. Certainly, there are very
few residential customers with demands in
excess of 20 kW, let alone the 50-kW mini-
mum listed in Table 1. Residential loads,
which are insignificant on an individual
basis, are huge collectively. The same is true
for the capacity available from generators
already in place in California and elsewhere
in the West. There just needs to be a simple
method to activate such generators without
incurring large transaction costs.

Various protocols have been suggested for
connecting distributed generators to the grid.
One of the most ambitious was to require
the distributed generators to become part of
the utility economic dispatch mechanism, as
part of a command and control system. In
addition to the meter and switchgear, the
customer would be required to pay for the
complete SCADA (System Control And Data
Acquisition) system required to connect it to
the control room and the OASIS system.
Some have estimated the investment
required to achieve this level of control to be
$150,000 per customer site. Simpler systems

that just include improved metering that can be read once a month by a meter technician may cost as little as $500. Obviously the transaction cost will be somewhere between these extremes.

Transaction costs will cause many small generators to decide to forgo helping the network during system emergencies. Table 5 supplements Table 4 by calculating the payback period the sample generator would require for various investments in the equipment necessary for it to help the network. At $250/MWh, the sample generator would earn $10/hour for helping the network keep the lights on. A $500 investment in transaction costs would require the sample generator to run 50 hours before this investment is paid back. Estimates that California will have rotating blackouts for over a 1000 hours in 2001 makes such an investment in transaction costs profitable for the sample generator, perhaps with a payback in less than a week. A $150,000 investment in transaction cost would require the sample generator to run for 15,000 hours before the investment is paid back. This could not be accomplished for 15 years, at least at the estimate of 1000 hours per year of rotating blackouts. Higher prices for emergency power are shown as reducing the number of hours for the sample generator to achieve a breakeven with its transaction costs.

Pricing Customer-owned Generation as a Commodity

With 30 GW of diesel generating sets available in California, the utilities face several pricing issues:

- How much capacity should the utility have under contract?
- Which generating sets should receive contracts to provide electricity?
- What price should the utility pay for capacity provided under such contracts?

These pricing issues can be addressed by treating electricity as a commodity with the price set as part of a true spot market.

Of course, there also remain some other "nuisance" issues, but they appear capable of solution.

Consider, for instance, the problem of non-parallel switching of distributed generation. The switching in Figure 2 reduces the ability of distributed generators to aid the network. Distributed generators would need to incur the cost of installing switching similar to that of Figure 1.

Next, consider how prices are communicated to distributed generators. The rise of the Internet allows real time prices to be posted and communicated to those distributed generators that wish to have real time notice of the price. Yet some distributed generators may decide to rely on radio announcements of alerts to determine when they will be operated.

Third, what rules limiting the dispatch of small generators that emit higher levels of pollution, such as standby diesel units, would apply? Emergency generating sets in California are certified to produce power only when the unit owner is unable to receive power from the grid, such as during a rotating blackout that affects the owner. New York seems to be moving to a procedure that allows emergency generating sets to produce power when the utility is about to implement blackouts, even if those blackouts would not affect the owner of the generating sets. Many states have not reached the point of defining an emergency precisely enough to distinguish between these two situations.

Overall, however, these issues can be simplified by treating electricity as if it were a fungible commodity. When electricity is viewed as a fungible commodity, and only then, can electricity can be bought and sold by customers on a true spot basis.

Moreover, this example of the capacity available through small, standby generating units shows the importance of integrating customer-owned generation into a true spot commodity market for electricity.

The aggregate total of this capacity is much greater than the projected shortfall, but with conventional ideas of operation and dispatch, any use of this capacity imposes an unacceptably high level of transaction cost per unit of energy, because of the small size of each individual unit.

By contrast, treating electricity as a commodity—including all distributed resources owned by customers—will reduce the effect of transaction costs to manageable levels. In short, with innovative dispatch, there ought to be enough distributed generation in place in California to meet the state's electrical demand. And there are ways for the utilities to set appropriate incentive prices for such distributed generation. **Ⓕ**

Mark Lively is a utility economic engineer in Gaithersburg, Maryland. For more information about this, and other utility issues, visit his website at www.LivelyUtility.com